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PHYS 362 HW 1

Problem 1

a.) I expect that $n(t)$ will decrease over time to eventually become very close to half of its original number of particles.

b.) n appears to approach 10, but not exactly 10 for all of time. The typical fluctuations in n appear to be about 5, so at certain points $n=15$, or $n=5$. During this simulation, n never returns to 20, or 0 for that matter.

c.) n appears to approach 100, but again it is not at 100 for all of time. The typical fluctuations in n appear to be about 10, where the largest is 20, so at certain points $n=110$ or $n=90$ and at its largest $n=120$. n never returns to 200 or 0.

d.) n appears to approach 1000, but not exactly 1000 for all of time. The typical fluctuations in n appear to be about 30, where the largest is 70, so at certain points $n=1030$ or $n=970$ and at its largest deviation $n=930$. n never returns to 2000 or goes to 0.

e.) There is a more distinct equilibrium state for $N=2000$. This equilibrium is $N=1000$.

f.)

Number of Particles	$\bar{n}$	σ	$\sigma/\bar{n}$
$N=2000$	999.4	32.57	0.0325896
$N=200$	101.0	7.21	0.0713861
$N=20$	10.45	2.114	0.2022967

As in increases, $\sigma/\bar{n}$ decreases and thus the fluctuations are smaller. From this we can deduce that the precision of equilibrium becomes better, more precise, as N increases.

Problem 2

a.) # of blue particles : 64 $L = 12.0$
# of yellow particles : 81 $\Delta t = 0.01$

	Avg. Potential Engergy	Avg. Kinetic Energy	Total Energy
Blue Particles	-4.402	0.1410	-4.261
Yellow Particles	-3.014	0.0920	-2.922

These quantities are not the same for each sub system

b.) The kinetic energy increases and the potential energy decreases

c.)

	Avg. Potential Engergy	Avg. Kinetic Energy	Total Energy
Blue Particles	-4.468	0.1555	-4.3125
Yellow Particles	-2.935	0.1598	-2.7752

The energy flowed from the blue particles to the yellow particles

d.) The average kinetic energy is the same for the two systems and thus kinetic energy is a better representation of temperature.

Problem 3

a.) $PV = NKT$

The variables that can be used to describe the state of the gas inside the flask are:

P - Pressure of the gas
V - Volume that the gas encapsulates
N - Number of Particles of gas in total
T - Temperature of gas

When the flask is moved from fluid A to fluid B

The pressure is not the same, it doubles
The volume remains constant
The Number of particles of gas remains constant
The temperature of the gas is not the same, it doubles

b.) When the flask is put in Fluid A, the two are in equilibrium. When the flask is removed and then put in fluid B, the two are not in equilibrium due to the pressure inside the flask changing. Therefore fluid A cannot be in equilibrium with fluid B.

Problem 4

a.) 5.8093×10^{23} molecules of CO_2, 2.107×10^{22} molecules of N_2, $1 \text{ mol} = 6.02 \times 10^{23}$ molecules

Molar Mass of $CO_2 = 0.04401 \frac{kg}{mol}$, Molar Mass of $N_2 = 0.0280134 \frac{kg}{mol}$

$$5.8093 \times 10^{23} \cancel{\text{molecules}} \cdot \frac{1 \text{ mol}}{6.02 \times 10^{23} \cancel{\text{molecules}}} = \frac{5.8093 \times 10^{23}}{6.02 \times 10^{23}} \text{ mol} = 0.965 \text{ mol of } CO_2$$

$$2.107 \times 10^{22} \cancel{\text{molecules}} \cdot \frac{1 \text{ mol}}{6.02 \times 10^{23} \cancel{\text{molecules}}} = \frac{2.107 \times 10^{22}}{6.02 \times 10^{23}} \text{ mol} = 0.035 \text{ mol of } N_2$$

$$m = 0.04401 \frac{kg}{mol} \cdot 0.965 \text{ mol} = 0.04246965 \text{ kg of } CO_2 \quad : \quad m_{CO_2} = 0.04246965 \text{ kg}$$

$$m = 0.0280134 \frac{kg}{mol} \cdot 0.035 \text{ mol} = 0.000980469 \text{ kg of } N_2 \quad : \quad m_{N_2} = 9.80469 \times 10^{-4} \text{ kg}$$

$$m = m_{CO_2} + m_{N_2} = 0.04246965 \text{ kg} + 9.80469 \times 10^{-4} \text{ kg} = 0.043450119 \text{ kg}$$

$$\boxed{m = 0.043450119 \text{ kg}}$$

b.) $PV = NKT$, $K = 1.38 \times 10^{-23} \frac{J}{K}$, $N = 6.02 \times 10^{23}$, $P = 9.2 \times 10^{6}$ Pa, $T = 740$ K, $m = 0.043450119$ kg

$$\rho = \frac{m}{V} \therefore V = \frac{m}{\rho} : P \cdot \frac{m}{\rho} = NKT \therefore \rho = \frac{Pm}{NKT} \qquad \frac{\cancel{N}}{m^2} \cdot \frac{kg}{1} \cdot \frac{1}{\frac{\cancel{N}m}{\cancel{K}}} \cdot \frac{1}{\cancel{K}} = \frac{kg}{m^3}$$

$$\rho = \frac{9.2 \times 10^{6} \text{ N/m}^2 \cdot 0.043450119 \text{ kg}}{6.02 \times 10^{23} \cdot 1.38 \times 10^{-23} \frac{J}{K} \cdot 740 \text{ K}} = 65.02 \frac{kg}{m^3} \approx 65 \frac{kg}{m^3}$$

$$\boxed{\rho = 65 \frac{kg}{m^3}}$$